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SOUTHWEST FISHERIES CENTER

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A GUIDE TO SHIPBOARD IDENTIFICATION OF SPINNER AND SPOTTED DOLPHIN SCHOOLS *(Genus Stenella)* IN THE EASTERN AND CENTRAL TROPICAL PACIFIC OCEAN

By

Staff Members of the Southwest Fisheries Center (NMFS)
and Inter-American Tropical Tuna Commission

ADMINISTRATIVE REPORT LJ-86-30

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INTRODUCTION

After almost thirty years of purse-seine fishing on dolphin schools to catch yellowfin tuna, it is now well known that only certain kinds of dolphins in the eastern and central tropical Pacific "carry fish." The two species that commonly carry fish are the spotted dolphin, Stenella attenuata, and the spinner dolphin, Stenella longirostris. Taxonomic studies conducted principally by Perrin and his colleagues have shown that, in the eastern and central Pacific, both species are made up of a number of geographical forms.

Current management regulations for the cetaceans taken in the purse-seine fishery provide quotas for each of the stocks. However, identification of these stocks in the field can sometimes be difficult:

(1) There is no single character, possessed by all individuals of a given stock, which allows unequivocal identification of the stock of an individual. Considering one or more characters, the averages for each stock are statistically different. Take for instance, size; one stock may be said to be larger. This means that the average adult size is larger and not that any individual of one stock is larger than any individual of another. Thus, stocks can be considered to be "modally" distinctive. Although the hypothetical "average" animal is clearly distinctive, there are likely individual animals from each stock that possess some characters which are representative of the other stocks in the species.

(2) Some of the characters which are used to discriminate between stocks are osteological, and thus are useless for identifying the stocks of species by the observer in the field.

(3) Some of the distinguishing characters may be difficult to see when sighting conditions are less than ideal.

Despite these reasons, determining the stock identity of a school with reasonable certainty is usually possible. The primary purpose of this guide is to describe how identification may be accomplished most consistently according to current criteria, using characters exhibited by the majority of adults in the school, that is, modal adult characters. The question of the kind of variation to expect within a stock is extremely important to identification, and we therefore offer the following general background.

For more details than this guide provides, interested readers can refer to the published studies of Perrin and his colleagues (Perrin 1969, 1972, 1975a & b; Perrin et al. 1979; and Perrin et al. 1985).

THE NATURE OF VARIATION WITHIN SPECIES

Biological species are "groups of interbreeding natural populations that are reproductively isolated from other such groups (Mayr 1970)." Reproductive isolation is inferred for a species based on morphological, genetic, biochemical, behavioral, or distributional criteria. For example, if a morphologist can unequivocally separate all specimens in large samples into two lots based on at least one morphological character, the investigator infers that the two lots represent two species. If the two forms are sympatric, it further supports the inference. If there are naturally occurring morphological intergrades, however, the inference is made that the group is not represented by two separate species, but that it is represented by variant forms within a single species. Such forms within a species have been variously called subspecies, stocks, varieties, races, populations, subpopulations, and geographical forms. The last is currently the term preferred by systematists. We will subsequently use both form or stock interchangeably.

Examples of geographical forms within a species are the major racial divisions in the human species (Mongoloid, Negroid, and Caucasoid), the geographical varieties of the domestic cat (Siamese, Burmese, tabby, Manx, etc.), the eastern and western meadowlarks, and steelhead and rainbow trout. In all these cases, morphological intergrades exist. Although a significant amount of reproductive isolation exists or has existed, complete isolation does not exist and only a single, highly variable species is involved. The result: if one is dealing with a geographically highly variable species, one can expect to have some difficulty identifying some single specimens and small samples to geographical form. The difficulty is compounded when two geographical forms have ranges that overlap. Gene flow between the forms could be limited by either breeding season differences or very strong social cohesion and stock exclusivity. Examples of this are the plains and woodland forms of the American bison, which winter together on the plains but feed and breed in separate habitats in the summer, and human tribes in New Guinea, which are sympatric but morphologically distinguishable.

Consider the problem of identifying a specimen in such a situation. In Figure 1, the variable X represents a single morphological character, say adult size. The curves represent the frequency distribution of adult sizes in the populations of the two geographical forms in an area in which the range of each form overlaps. The important point here is that each curve includes

some individuals of one form that more closely resemble the modal or average size of the other form. For example, if the observer only knows the size of specimen A, he can not assign it to either of the two populations with any confidence. However, more information may make it possible to identify the specimen. If it were collected in close association with specimens B - F, for example, one could conclude with some confidence that the specimen belongs to the population represented by the frequency distribution on the right side of the figure. The individual in that case would belong to the population on the right even though its size was characteristic of the left-hand population. Examples of other types of information that might prove useful in identifying the individual specimen are additional morphological characters, behavior, date of collection, exact locality of collection, and reproductive condition.

What is the mechanism for producing such an individual? Because the nature of the geographical variation involved is usually know only in general, an individual, with apparently "aberrant" character(s), could be (1) as above, a normal variant, representing one of the stocks, (2) a hybrid, the result of gene flow between the adjacent stocks, or (3) an intermediate variant on a continuum of clinal variation over a broad geographic area. This last situation could occur when, in reality, only one stock existed. The variation in the species in question would be continuous, that is, no abrupt "breaks" in the distribution. The graph in Figure 1 would show only a single, but very broad, peak.

To identify the stock of an individual, then, these points are paramount: (1) we are dealing with forms within a species, not separate species; (2) the stock of Single specimens or small samples may be difficult or impossible to identify; (3) the more information collected and considered, the greater the likelihood that one will be able to identify a specimen, and the greater the likelihood that the identification will be correct; and (4) we do not yet know the whole story of what these populations are and how they vary.

STOCKS OF SPINNER DOLPHINS

Modal Characters and Their Geographic Distribution

The following summarizes current understanding of the five stocks of spinner dolphins: Costa Rican, eastern, northern whitebelly, southern whitebelly, and Hawaiian.

Costa Rican Spinner Dolphin

This form is the longest and slenderest of the eastern or central tropical Pacific spinner dolphins. It is characterized by a prominent elongated beak and dark monotone gray body pigmentation (Fig. 2). This form may or may not have the white

genital patch typical of other forms. Unfortunately little is known about this type of spinner. Its range is thought to be limited to within 50 nm from shore along the coast of Central America between the Gulf of Tehuantepec to the Bay of Panama.

Eastern Spinner Dolphin

This form resembles the Costa Rican spinner in its generally monotone gray pigmentation and erect, triangular to forward-canted dorsal fin. The fin is canted only on adult males. The eastern form differs from the Costa Rican form in its relatively shorter rostrum and body. It has genital and axillary patches of white of variable sizes (Fig. 3). The eastern spinner dolphin is found off the coast of Mexico to at least as far west as 130° W longitude, as far north as 25° N latitude, and as far south as the equator.

Northern and Southern Whitebelly Spinner Dolphin

The typical southern and northern whitebelly spinner dolphins have a triangular dorsal fin and a dark dorsal cape with a dorsal overlay that extends backward and downward to behind the genital region (Fig. 4). The southern form is distinguished from the northern form by a closer resemblance to the Hawaiian spinner dolphin, having a more tripartite pigmentation pattern and slightly longer body and larger head. Some northern and southern whitebelly spinner dolphins have a "step" pattern, where the shape of dorsal overlay is such that the white belly coloration extends laterally about a third of the way up the body only above the genital region. The eastern form, when white along the ventral surface, does not have this step.

The animals range west to at least 150° W longitude. The southern form is separated from the northern form by a distributional gap near the equator.

Hawaiian Spinner Dolphin

This form is a large animal with a large head, a well-defined, three-part color pattern, and a slightly falcate dorsal fin (Fig. 5). It is found near the Hawaiian Islands, and its range is not thought to overlap the ranges of the southern and northern whitebelly spinner dolphins or the ranges of other spinner dolphins to the south and west in Polynesia.

Overlap of Northern Whitebelly Spinner
and Eastern Spinner Dolphin Ranges

The eastern and northern whitebelly spinner dolphins are sympatric (and are occasionally found together in the same

school[1]) over a broad area of their respective ranges. The area of range overlap extends from near the Central and South American coasts above the equator, west-north-westward to near 135° W longitude and at least to 16° N latitude (Fig. 6).

Single-stock spinner dolphin schools may contain individuals that exhibit character attributes resembling those of one or the other or both forms. Generally, though, "pure" schools consisting of one or the other of these two forms tend to exhibit the characters upon which their respective taxonomic definitions were originally based (for example, see Figure 24 in Perrin et al. 1985).

Contiguous Ranges of Eastern and Costa Rican Spinner Dolphins

Perrin et al. (1985) reported that, although the range of the eastern spinner surrounds the range of the Costa Rican spinner, there have been no supported sightings of the eastern spinner dolphin within the known range of the Costa Rican, that is within 50 nm from the coast and between 7° and 15° N latitude. It seems that the eastern form may well be largely or completely excluded from the range of the larger, though relatively similar Costa Rican dolphin.

Discontinuous Ranges of Northern and Southern Whitebelly Spinner Dolphins

Based on differences in color, morphology, ovulation rate, and the area of apparently low sighting frequency near the equator, the whitebelly spinner dolphins have been divided into northern and southern stocks (Smith 1983, Perrin et al. 1979, Au et al. 1984, Schnell et al. 1982, Schnell et al. 1985). There appears to be approximately a 5° latitudinal break between the ranges of the two forms, but this discontinuity may be more a result of a decrease in sightings than a true hiatus. Until further work clarifies the situation, whitebelly spinner dolphins found south of 1° S latitude are provisionally considered southern whitebelly spinner dolphins; those north, northern whitebelly spinner dolphins (Perrin et al. 1985).

STOCKS OF SPOTTED DOLPHINS

Modal Characters and Their Geographic Distribution

There are four stocks of spotted dolphins: coastal, northern offshore, southern offshore, and Hawaiian.

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[1]Actually, separate groups or schools in one net haul, but defined as a "school" in tuna/porpoise terminology.

Coastal Spotted Dolphin

This form is the largest of the four stocks of spotted dolphins in the eastern Pacific (Fig. 7). It has a robust, profusely spotted body, falcate dorsal fin, and large head (Perrin 1975a & b). The coastal spotted dolphin ranges within 100 nm of the coastline or of coastal islands from northern Mexico to Ecuador (Perrin et al. 1985). Reports of coastal-like spotted dolphin schools near islands in far offshore waters are scant and, although at least one such report seems reliable, none is supported by specimens or measurements (Perrin et al. 1985).

Northern Offshore Spotted Dolphin

This form is similar to, but considerably smaller than the coastal form. Adult males average 23 cm shorter, and adult females average 19 cm shorter (Fig. 8). Compared with the coastal form, the northern offshore form on the average has a more slender head and body and has fewer spots (Perrin 1975a & b). It occurs from near the coast of southern Mexico as far north as 25° N latitude, off Central and South America to 1° S latitude, and probably to at least as far west as 145° W longitude (Perrin et al. 1985).

Southern Offshore Spotted Dolphin

The modal morphotype of this form is slightly smaller and less spotted than the northern offshore form. It has a distinctly contrasted dark cape and white lateral field pattern and a slightly larger head. The range of the southern stock extends from the South American coast to at least as far west as 140° W longitude and from 1° S latitude (where sightings of offshore spotted dolphins are relatively rare) to at least 12° S latitude (Perrin et al. 1985).

Hawaiian Spotted Dolphin

This form resembles the southern offshore form more than the northern one because it has the larger head, the more contrasting cape/lateral field pattern, and the reduced spotting. The range is apparently restricted to Hawaiian waters.

Partially Sympatric Northern Offshore and Coastal Forms

Northern offshore spotted dolphins occupy the same area as the coastal spotted dolphins throughout much of the coastal's range, that is to 100 nm offshore from northern Mexico to Ecuador. However, the two forms are not known to school together.

Provisional Boundary of the Northern and Southern Offshore Spotted Dolphins

A provisional boundary has been drawn at 1° S latitude to separate the northern and southern offshore stocks. This "line of convenience" is based on an area of decreased sightings identified in earlier studies. Although this "band of low density of sightings...is still present...[it is] not as well defined as previously (Perrin et al. 1985, p.14)."

STOCK DISCRIMINATION OF DOLPHIN SCHOOLS

The Essentials

Adult Modal Characters Determine Stock Identity

Only the adult (largest) animals in the school should be used for discriminating between stocks. Using subadult animals to identify the stocks leads to incorrect identifications. For instance, juvenile eastern spinner dolphins often have light-colored (not white) bellies and could be confused with juvenile and adult whitebelly spinner dolphins. If body sizes are not taken into account, a exclusively eastern spinner school, containing young, could be identified as a mixed school of eastern and whitebelly spinner dolphins. Also, it would probably be impossible for an observer to differentiate between eastern spinner dolphins and subadult Costa Rican spinner dolphins if they occurred together in one school or on the deck without adult Costa Ricans for comparison.

Behavior Helps Distinguish True Mixed Schools

Behavior of the individuals within the school can sometimes give clues as to whether the school comprises two stocks (to date a very rare occurrence). If individuals representing two different forms seem present in the chase or net in different groups, and the individuals of one type respond as a unit, the school may actually be a true mixed school. On the other hand, if segregating behavior is not apparent, the presumption is that a single-stock school is present.

If there is no opportunity to observe behavior and enough doubt exists about the modal characters, it is perfectly legitimate to make no stock identification at all. The alternative of leaving the stock of the dolphins unidentified has probably been under-used in the past.

Geographic Area Must be Used Cautiously

The geographic area in which the set is being made should be cautiously taken into account when making stock identification. In most cases, the extent of the ranges of the spinner and spotted dolphin stocks probably has been sufficiently well defined to make it unlikely that an observer would encounter a dolphin stock very far from the known (or anticipated) home range. Nevertheless, position should never be used by itself in making an identification.

For example, a school of spotted dolphins within 100 nm from shore should be identified as coastal only if it can be determined that the modal adult size and spotting is typically coastal. If adult size and extent of spotting cannot be determined satisfactorily for a spotted school seen within 100 nm of land, the observer should identify only the species and leave the identity of stock as unknown. A spotted dolphin school sighted farther than 100 nm from shore should be identified as offshore unless there is certainty that the animals are sufficiently large and sufficiently spotted to fit the definition of coastal. Because this would be an extension of the known range, extensive documentation (such as specimen life history data, samples, or photos) would be required to support the identification.

A spinner dolphin school within the known range of the Costa Rican stock (between 7° and 15° N latitude and within 50 nm from shore) should be identified either as eastern or Costa Rican stock only if adult modal body length and beak length can be satisfactorily documented. Otherwise, the stock of the dolphins should remain unidentified.

The Problems

No matter how prepared an observer may be to make stock identifications at sea, he is confronted by a host of factors that hamper attempts to identify the stock of a dolphin school.

Dolphins at a distance or during the chase are difficult to identify. Often, they may scarcely break the water surface, and all an observer may see are a few dorsal fins and glimpses of dark dorsal capes. If the observer is fortunate, he may see one or two animals leap or spin, which might provide useful information about the breaching animals. Such sightings, however, are hardly sufficient to detect modal characters. In such cases, it is best to identify only the species of the animals (provided, of course, the diagnostic characters of the species are observed).

Many resting or feeding schools will run as soon as they begin to detect the approaching boat from several miles away.

Frequently this will bring at least some of the animals out of the water. When they run from the boat, they tend to break to the side--that is, obliquely or perpendicularly to the boat's direction of travel, providing useful views of the dolphins' sides. Some cases are known in which groups of individuals in mixed schools have displayed segregating behavior when running. In other cases, animals of one form may fade back in a group away from the main school to avoid the speedboats and seiner. The observer should anticipate such behavior in evaluating the composition of an alarmed school.

Unless the boat turns and follows their course, the animals may halt and immediately submerge. If the observer is not quick enough in examining the school before then, the opportunity to identify adult modal features may be lost.

Although the purse-seine set sequence offers some of the best opportunities for observing dolphins (especially when they are in the net), two important events may occur which prevent accurate identification of the school. In either case, not much can be done, and we only present the situation to emphasize that the animals in the net do not necessarily provide unequivocal identification of the school. First, from the time a school is sighted, through the chase and set, and until capture (when the bottom of the net is fully pursed), segments of a school may escape before they are identified. For example, if a school is truly mixed when the chase begins, but a subschool consisting of animals of one stock responds first to the approaching boat or pursuing speedboats by scattering or fading back unnoticed, only one stock would be identified in the set.

The other possibility is that the capture situation may alter behavior. It may artificially inhibit the natural segregating behavior between members of two different stocks in a mixed school exhibiting high variation. An observer might not be able to detect a second stock in the school in the absence of segregating (or simply, different) behavior. Conversely, the capture situation might cause some age-specific or sex-specific segment of an actually pure school to behave as if it belonged to a different stock.

Because of the quota system established by the U.S. government to regulate sets on dolphins, skippers must avoid setting on schools containing dolphins belonging to any prohibited stock. This requires that the stock identification of a school be made before a decision is made to set the net. However, the main drawback to identification before the set is that, except for the situations in which the school can be observed to separate while running, there are few opportunities to observe any natural segregating behavior. For most schools in which adult modal characters are observable and sharply diagnostic, identification is not a particularly difficult

problem. The difficulty is much greater in the cases where schools exhibit two adult modes of the same species, and it is especially difficult when there are intermediate forms and no "natural" segregating behavior can be discerned. Under this latter set of circumstances, there is no alternative to using the name of the stock whose form is represented by the greatest number of adults in the school.

Examples

It is because of the described obstacles--impaired ability to observe, variation, mixed schools, individuals that exhibit intermediate features, the resemblance of animals of one stock to those of another stock, and overlapping stock ranges--that the observer must use as many discriminating characters as possible in trying to determine the stock composition of eastern Pacific dolphin schools. As has been repeatedly stressed, stock identifications of the school are not based on any single individual but on the consideration of the aggregate characters of individual adults in the school as a whole.

The following are examples of situations an observer may encounter. The observer can test his understanding of the principles of identifying schools by reading the paragraph and identifying the schools and individual mortalities. He can then compare his answer with the answer provided in the paragraph that follows the example.

(1) A school of spinner dolphins is captured 200 nm off the coast of Mexico. Most have triangular dorsal fins, and about 20% have forward-canted dorsal fins. All appear to be a uniform gray color. Six dolphins are killed during the set: three have a small genital white patch; two have a white patch that extends to the flippers; and one has a patch that extends all the way to the throat.

Record this school as 100% eastern spinner with a mortality of 6 eastern spinner dolphins. The dead animals illustrate the variation in color pattern that may be seen.

(2) A school of dolphins is sighted in three distinct groups 5 nm off Clipperton Island. Spinner dolphins can be seen in the first two groups (20%), with the majority of the school in a third group that is composed of spotted dolphins (80%). All three groups are herded together and captured without any evasion. All of the spinner dolphins are of the eastern form--having triangular or forward-canted dorsal fins and a uniform gray color. Several animals are spinning, two of which have light-colored bellies and are relatively small. One spinner dolphin is killed during the set; it also has a very light ventral surface and is 120 cm long.

Record this school as 80% northern offshore spotted dolphins, 20% eastern spinner dolphins, with a mortality of one eastern spinner. The animals with light-colored bellies should not be called whitebelly spinner dolphins because they are juveniles that have not yet developed their adult characters. The spotted dolphins are not of the coastal stock because this stock is found only close to the mainland or coastal islands, and not close to pelagic islands, such as Clipperton Island.

(3) Two-hundred and fifty nm offshore of Mexico, a school is chased that is spread over several miles. Just before the net is set, the school appears to be composed of 75% spotted dolphins and 25% unidentified spinner dolphins. During pursing, two distinct groups of spinner dolphins form--one group on each side of the spotted dolphins. One group (10% of the total school) contains eastern-like animals, the other group (15%) contains whitebelly-like animals. Four adult spinner dolphins are killed: one is a male with a forward-canted dorsal fin, uniform gray coloration, and a white genital patch; one is a female with a triangular dorsal fin, uniform gray coloration, and a small genital white patch; and the other two have triangular dorsal fins and white bellies that extend halfway up the sides. One juvenile spinner with a light-colored belly is killed also.

Record the school as 75% northern offshore spotted dolphins, 15% whitebelly spinner dolphins, and 10% eastern spinner dolphins. However, because of the possible range of appearance for a single stock, it is impossible to know with certainty which of the two groups the five dead animals came from. Thus record the mortality as five unidentified spinner dolphins.

(4) A large scattered school of about 500 animals is chased 300 nm off the coast of Mexico. Most of the school are spotted dolphins (90%), the rest are spinner dolphins with triangular dorsal fins, but only the gray dorsal surfaces are visible. The spinner dolphins evade capture.

Record the school as 90% northern offshore spotted dolphins and 10% unidentified spinner dolphins because the ventral surfaces of the animals were not seen. The presence of triangular dorsal fins is not enough to make an identification because the fins of the vast majority of whitebelly spinner dolphins and many eastern spinner dolphin are triangular.

(5) A school of 700 spinner dolphins is sighted at a distance of 35 nm off Guatemala. They appear to be uniformly gray with some animals having forward-canted dorsal fins and the rest with triangular dorsal fins. You do not get a good look at the animals and no set is made.

Record the school as 100% unidentified spinner dolphins since they could be either Costa Rican or eastern spinner

dolphins and since the animal size and rostral length were not seen well enough to discriminate between the two forms.

(6) At 8° N, 95° W a school of spotted dolphins (80%) and spinner dolphins (20%) is chased. About half of the spinner dolphins are cut out of the set; the rest are captured. In the net, the spinner dolphins are not showing much of their ventral surface although some animals have a small white genital patch. In some the white extends laterally about a third of the way up the body only above the genital region (the "step" pattern that is more typical of the whitebelly form) and in others this "step" is missing (more typical of the eastern form). A few forward-canted dorsal fins are seen. Four spotted and four spinner dolphins are killed during the set; of the spinner dolphins, one female has a small genital patch, the other three are white ventrally with a "step" pattern. All have triangular dorsal fins.

Record the school as 80% northern offshore spotted dolphins and 20% unidentified spinner dolphins with a mortality of four spotted dolphins and four unidentified spinner dolphins. The spinner dolphins are unidentified because the characters of most were not seen, and the few animals that were observed showed characters that were not clearly one stock or the other.

(7) Twenty nm off the coast of Panama, six spotted dolphins approach the boat and ride the bow. All are juveniles with light or no spotting dorsally.

Record the group as unidentified since none have the adult characters (amount of spotting and size) that would allow you to distinguish between the coastal or offshore forms.

(8) Just south of the Galapagos Islands and a school of 600 spinner dolphins is sighted. Because they are leaping and spinning, you can see that most have white bellies that extend over halfway up the sides. All have triangular dorsal fins except for two large individuals with forward-canted dorsal fins. No set is made.

The school should be recorded as 100% southern whitebelly. The individuals with the forward-canted dorsal fins are not called eastern spinner dolphins since this character is seen in some whitebelly spinner schools due to the modal nature of the character.

(9) About 250 nm off the coast of Panama, 300 dolphins are chased and captured; 60% are spotted dolphins, 40% are spinner dolphins. Of the spinner dolphins, 20% are eastern-like and 80% are whitebelly-like. Animals of these two forms intermingle freely during the chase and in the net. Five spinner dolphins are killed; one large male has a large white genital patch and a

forward-canted dorsal fin, and the other four have white bellies and sides with triangular dorsal fins.

Record the school as 60% northern offshore spotted dolphins and 40% whitebelly spinner dolphins with a mortality of five whitebelly spinner dolphins. Since only a small proportion are eastern-like, and no segregating behavior was observed, these animals should be considered whitebellies because of the modal nature of the characters.

(10) Three-hundred nm off Panama, a school of 60% spotted dolphins and 40% spinner dolphins is chased and captured. All of the spinner dolphins are in a single group, but 50% appear eastern-like and 50% appear whitebelly-like. Three spotted dolphins and two adult female spinner dolphins are killed. One of the spinner dolphins has a small white genital patch, the other has a white belly that extends halfway up the sides.

Record the school as 60% northern offshore spotted dolphins and 40% unidentified spinner dolphins with a mortality of three northern offshore spotted dolphins and two unidentified spinner dolphins. The spinner dolphins are so identified because no segregating behavior was seen.

SUMMARY

Because of variation, mixed schools, individuals that exhibit intermediate features, the resemblance of animals of one stock to those of another stock, and overlapping stock ranges, it is important for an observer to use as many discriminating characters as possible in trying to determine the stock composition of eastern and central tropical Pacific dolphin schools. Stock identifications of the school are not based on any single individual but on the consideration of the aggregate characters of individual adults in the school as a whole.

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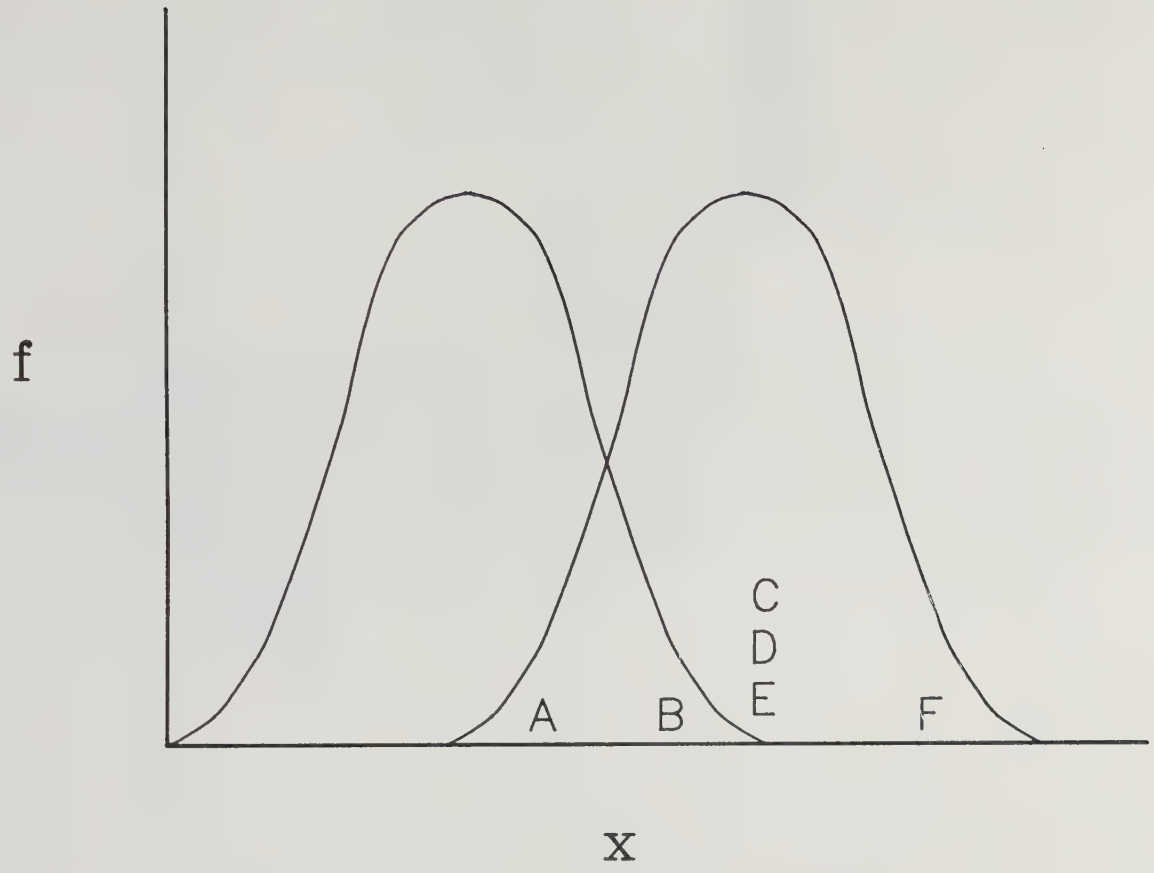

Figure 1. Graph illustrating overlap in hypothetical frequency distribution of a character (X). The uppercase letters represent individual specimens. Each curve includes some individuals of one form that more closely resemble the average X of the other form.

Figure 2. School of spinner dolphins showing elongate beaks characteristic of the Costa Rican spinner dolphin stock.

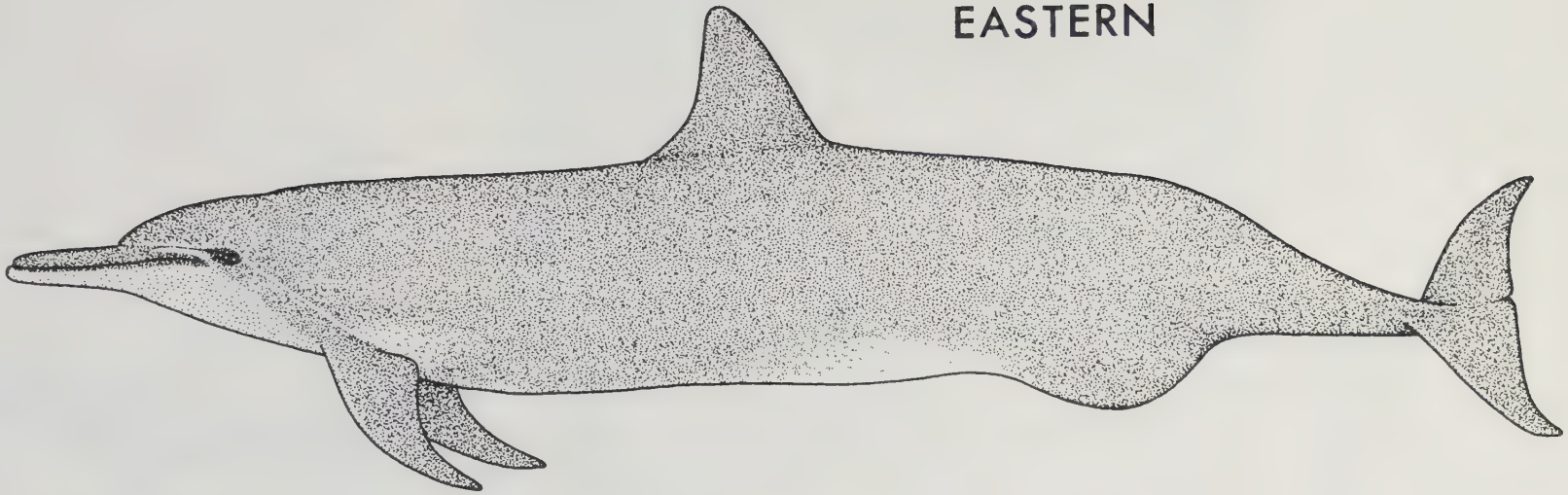

Figure 3. A forward-canted dorsal fin and enlarged "keel" in the genital area are most pronounced in the male eastern spinner dolphin.

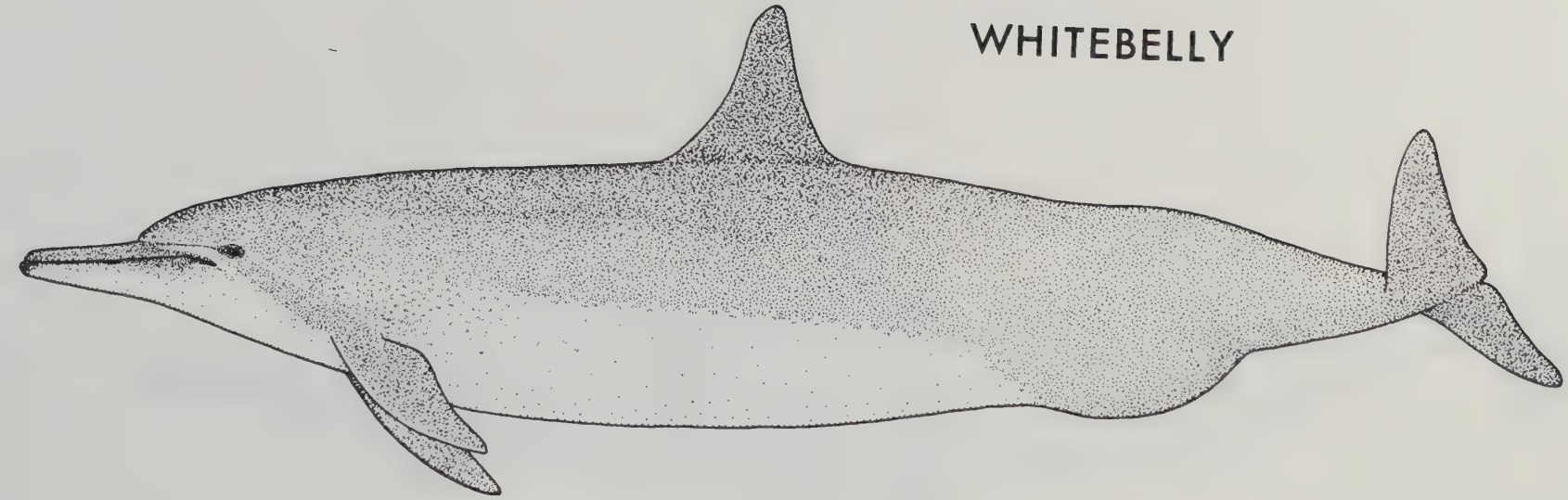

Figure 4. Coloration patterns vary in the typical whitebelly spinner dolphin forms. In the whitebelley spinner dolphin form, the pattern is bipartite.

Figure 5. Hawaiian spinner dolphins showing proportionately elongated beaks and tripartite coloration.

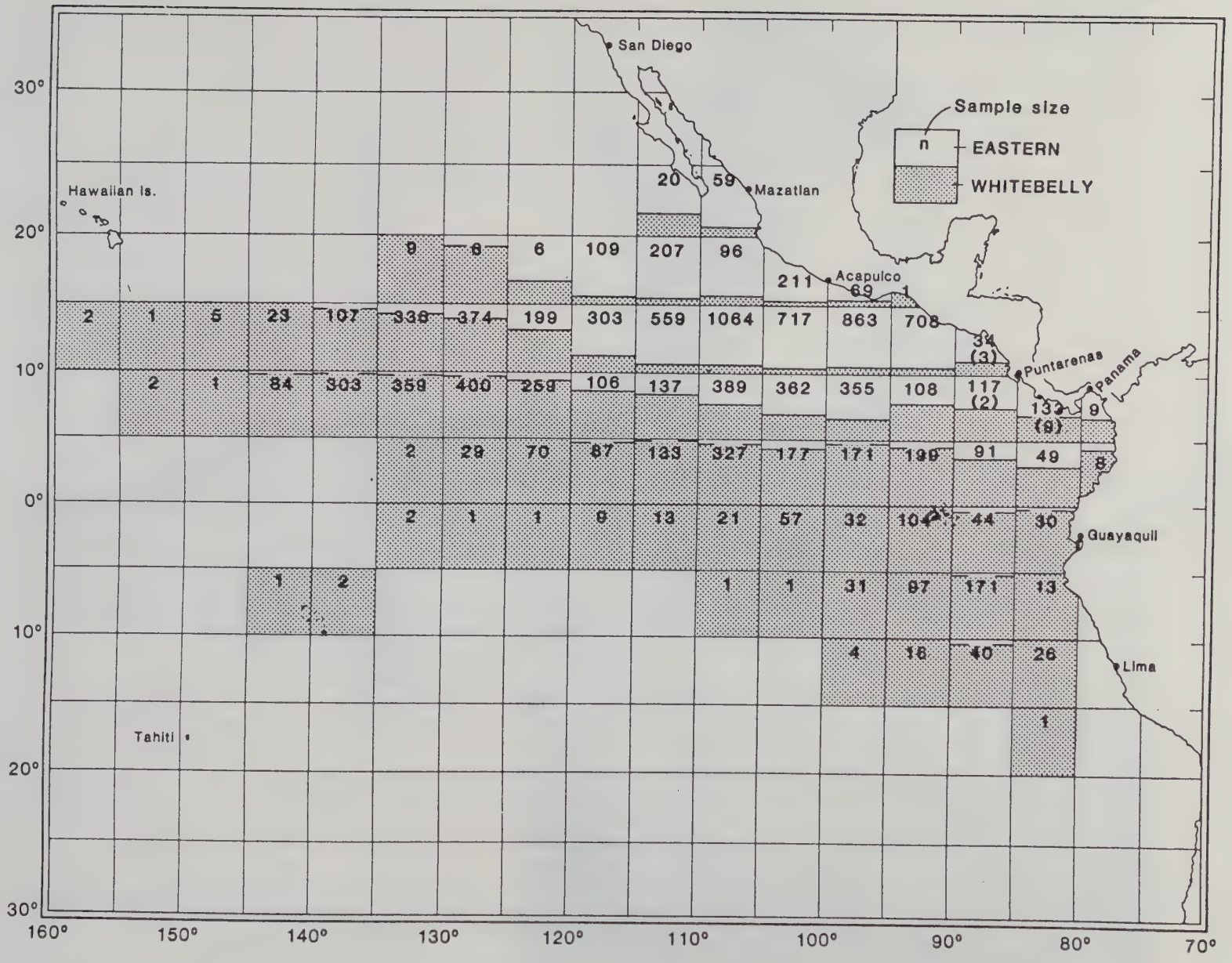

Figure 6. Stock composition of spinner dolphins by 5^{O} square sightings. Interface of white and gray squares shows known region of sympatry of eastern and northern whitebelly spinner dolphin stocks (from Perrin et al. 1985).

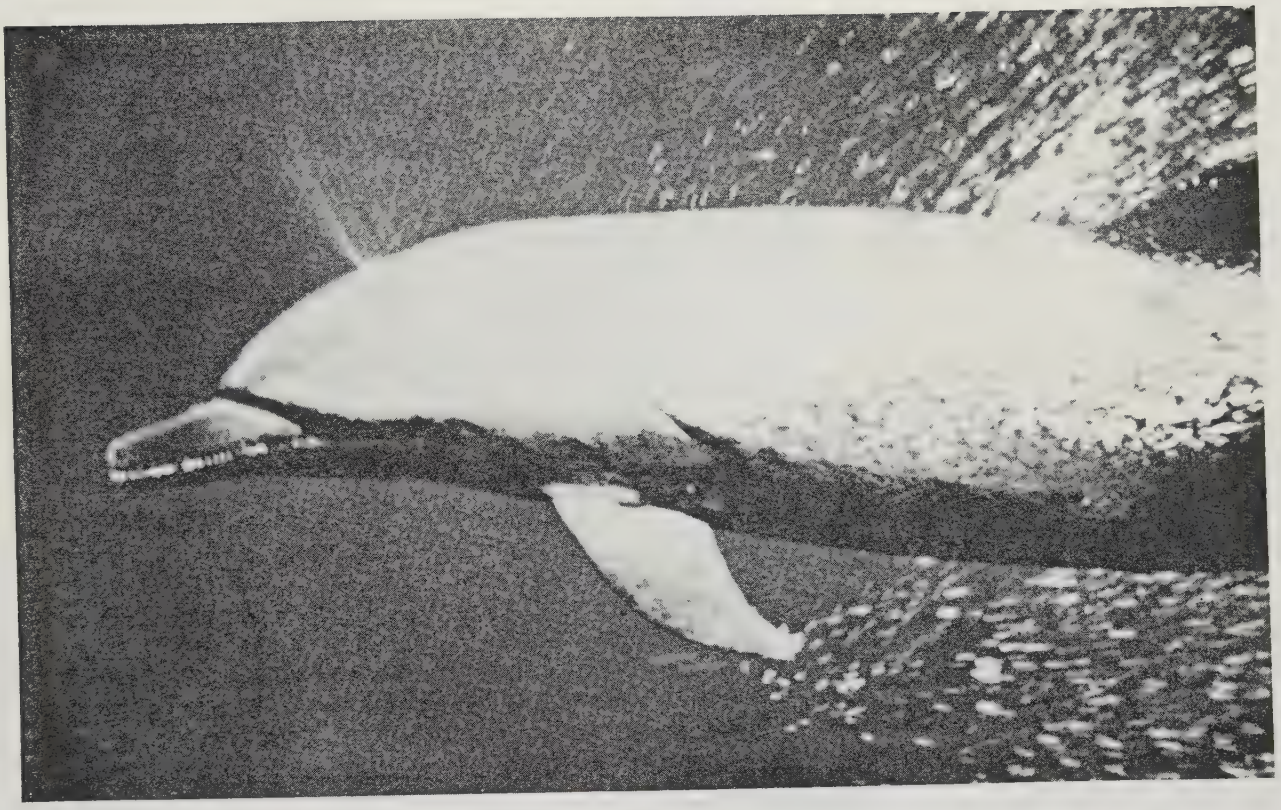

Figure 7. Heavy spotting is typical of the coastal form of the spotted dolphin.

Figure 8. Typically the northern offshore form of the spotted dolphin has medium to slight spotting.